General

Guideline Title

ACR Appropriateness Criteria® stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae.

Bibliographic Source(s)

Daffner RH, Weissman BN, Appel M, Bancroft L, Bennett DL, Blebea JS, Bruno MA, Fries IB, Hayes CW, Kransdorf MJ, Luchs JS, Morrison WB, Palestro CJ, Roberts CC, Stoller DW, Taljanovic MS, Tuite MJ, Ward RJ, Wise JN, Zoga AC, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae. [online publication]. Reston (VA): American College of Radiology (ACR); 2011. 9 p. [40 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Daffner RH, Weissman BN, Bennett DL, Blebea JS, Jacobson JA, Morrison WB, Resnik CS, Roberts CC, Rubin DA, Schweitzer ME, Seeger LL, Taljanovic M, Wise JN, Payne WK, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® stress/insufficiency fracture, including sacrum, excluding other vertebrae. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 8 p. [48 references]

The appropriateness criteria are reviewed biennially and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Stress (Fatigue/Insufficiency) Fracture, Including Sacrum, Excluding Other Vertebrae

Variant 1: Suspect stress fracture. First imaging modality.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9	Radiograph is a required first step before consideration of other imaging.	Varies
MRI area of interest without contrast	1		O

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without and with contrast	1		O
Tc-99m bone scan whole body with SPECT area of interest	1		
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Suspect stress fracture in patient with "need-to-know diagnosis", not hip or sacrum. Radiographs normal.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest repeat in 10 to 14 days	9	Many patients will recover in the interim and not return.	Varies
MRI area of interest without contrast	9	In this clinical situation, many clinicians would wait until repeat radiograph is negative before going to MRI; with an anxious patient or clinician, or repeated negative radiographs, MRI is the favored next imaging modality.	O
MRI area of interest without and with contrast	1		O
Tc-99m bone scan whole body with SPECT area of interest	1	If the patient or clinician is too anxious to wait for repeat radiographs, could do MRI or bone scan (but not both); panel prefers MRI since it is usually more specific than bone scan.	
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Suspect stress fracture, not hip or sacrum. Radiographs normal. Bone scan positive and nonspecific.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	9		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest repeat in 10 to 14 days	7	For confirmation or question of complication.	Varies
CT area of interest without contrast	5	If MRI is contraindicated.	Varies
MRI area of interest without and with contrast	1		O
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: Suspect stress fracture in otherwise normal patient. Radiographs normal.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	2	Not indicated if radiographs and MRI were normal; but if the studies were radiographs and bone scan that were normal and there is persistent pain, the clinician might re-examine the diagnosis and consider MRI, looking for soft-tissue injury.	O
MRI area of interest without and with contrast	1		O
X-ray area of interest repeat in 10 to 14 days	1	Not necessary. No further imaging is warranted.	Varies
Tc-99m bone scan whole body with SPECT area of interest	1		
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: Clinical differential fracture versus metastasis in long bone. Radiographs normal, bone scan hot but nonspecific.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	9	Contrast may be reserved for ambiguous situations such as adjacent soft-tissue mass.	O
MRI area of interest without and with contrast	8	Usually appropriate noncontrast scan. See statement regarding contrast in text under "Anticipated Exception."	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Radiologic Procedure	Rating	Comments	RRL*
CT area of interest without contrast	4		Varies
X-ray area of interest repeat in 10 to 14 days.	1	Too anxiety producing. An occult metastasis is unlikely to appear on radiographs in this period.	Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Clinical differential insufficiency fracture versus metastasis in sacrum. Radiographs normal, bone scan hot but nonspecific.

Radiologic Procedure	Rating	Comments	RRL*
CT sacrum without contrast	8	First choice. Definitive for diagnosis of fracture.	
MRI sacrum without contrast	6	Alternative choice may show other cause for pain or the fracture. Contrast may be reserved for ambiguous situations.	O
MRI sacrum without and with contrast	1		O
X-ray sacrum repeat in 10 to 14 days	1	Very low sensitivity.	
CT sacrum with contrast	1		
CT sacrum without and with contrast	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Suspect insufficiency fracture in sacrum/pelvis; elderly patient. Radiographs normal. Bone scan hot in linear pattern typical for fracture.

Radiologic Procedure	Rating	Comments	RRL*
MRI pelvis without contrast	6	For confirmation.	O
CT pelvis without contrast	4	For confirmation.	

Radiologic Procedure	Rating	Comments	RRL*
MRI pelvis without and with contrast	1		O
CT pelvis with contrast	1		
CT pelvis without and with contrast	1		
X-ray pelvis repeat in 10 to 14 days	1		
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Suspect insufficiency fracture (any location) in osteoporotic patient or patient on long-term corticosteroid therapy. Radiographs normal.

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest repeat in 10 to 14 days	9	Panel agrees one of these three exams should be done. The clinical condition and location will dictate which. If the diagnosis is not urgent, repeat radiographs may be all that is necessary. If there is greater urgency, the panel favors MRI over bone scan because bone scans can be falsely negative in this patient population.	Varies
MRI area of interest without contrast	9	Panel agrees one of these three exams should be done. The clinical condition and location will dictate which. If the diagnosis is not urgent, repeat radiographs may be all that is necessary. If there is greater urgency, the panel favors MRI over bone scan because bone scans can be falsely negative in this patient population.	O
Tc-99m bone scan whole body with SPECT area of interest	9	Panel agrees one of these three exams should be done. The clinical condition and location will dictate which. If the diagnosis is not urgent, repeat radiographs may be all that is necessary. If there is greater urgency, the panel favors MRI over bone scan because bone scans can be falsely negative in this patient population.	
MRI area of interest without and with contrast	1		O
CT area of interest without contrast	1		Varies
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Suspect insufficiency fracture in osteoporotic patient or patient on long-term corticosteroid therapy. Radiographs and bone scan obtained within the preceding 48 hours are normal.

Radiologic Procedure	Rating	Comments	RRL*
MRI area of interest without contrast	9	If diagnosis is nonurgent, repeat radiographs; otherwise go to MRI. Bone scan may be falsely negative in this patient population.	O
X-ray area of interest repeat in 10 to 14 days	5	Not sensitive for sacral lesions.	Varies
CT area of interest without contrast	4		Varies
MRI area of interest without and with contrast	1		O
CT area of interest with contrast	1		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Stress fractures are osseous injuries that are classically believed to result from muscle action on bones. The common denominator for all stress fractures is that they occur as the result of repeated cyclical loading of bone with forces less than that required for an acute traumatic fracture. Stress fractures occur in two varieties: *fatigue fractures* that are due to abnormal activity on bone of normal mineralization, and *insufficiency fractures* that are due to normal activity on bones that are deficient in mineral. Furthermore, it is now recognized that certain medical procedures such as radiation therapy and long-term osteoporosis treatment with bisphosphonates predispose patients to stress fractures. Both varieties are now being more frequently recognized as the cause of pain in patients. Although many fatigue/insufficiency fractures are self-limited because they heal with or without diagnosis, there is usually value to making the diagnosis. With continued activity, some stress fractures will progress to completion and require more invasive treatment or delay in return to activity. Also the differential diagnosis of stress/insufficiency fractures includes entities that would be treated significantly differently than stress fractures (osteoid osteoma or osteomyelitis in the younger patient, metastases in the older patient). The clinical picture is further clouded by the fact that many older patients with insufficiency fractures have histories of previous malignancy.

Radiographs

Some clinical settings are often highly suggestive of a diagnosis of fatigue or insufficiency fractures. Such settings include repetitive or new athletic activity for fatigue fractures, osteoporosis, irradiated bone, or resumption of activity post-arthroplasty for insufficiency fractures. Certain athletic activities often result in specific sites of fatigue fracture. Insufficiency fractures also occur at fairly predictable sites. Thus, radiographic diagnosis using such pattern and site recognition is usually quite specific. Late radiographic findings are often suggestive in appearance as well: linear sclerosis, often perpendicular to the major trabecular lines. However, early radiographic findings are less specific (subtle periosteal reaction; "gray cortex sign") or even nonexistent. Radiographs in stress fractures may be negative initially in 60% to 82% and remain negative in 46% to 60%. Radiographs are more likely to be negative initially in older or osteoporotic patients with insufficiency fractures, particularly when they occur in the pelvis or sacrum. Additionally, radiographs may remain negative depending on the timing of re-imaging, the patient's metabolic bone status, and the type and location of the fracture. Thus, radiographs are specific but significantly insensitive. Despite this limitation, all authorities agree that radiographs should be the initial imaging modality; if the findings are conclusive, no further imaging need be performed.

Bone Scan

Radionuclide bone scans have long been accepted as extremely sensitive for detecting stress fractures. Planar scintigraphy combined with single

photon emission computed tomography (SPECT) is more accurate in diagnosing stress injuries than planar scintigraphy alone. The objection to the studies quoting high accuracy for bone scan is that, in all of them, a positive bone scan is taken as the "gold standard" for detecting stress fractures and therefore sensitivity is 100%. However, depending on the staging criteria for bone scan pattern, the abnormalities may in fact be stress reactions rather than actual stress fractures. Nonetheless, it is clear that bone scans show stress fractures days to weeks earlier than radiographs in many instances, and differentiate between osseous and soft-tissue injury as well. In some cases, the pattern of fracture is such that the diagnosis is secure, and no further imaging is required (for example, the "H sign" or *linear* and *vertical distribution* of sacral insufficiency fractures). However, in most cases bone scans lack specificity (with synovitis, arthritis, degenerative joint disease, stress reactions, and tumor appearing similar), and supplemental imaging with magnetic resonance imaging (MRI) or computed tomography (CT) may be necessary for conclusive diagnosis or to avoid false positives.

Because of the sensitivity of bone scan, 80% of all fractures show some scan abnormality 24 hours post injury and 95% at 72 hours. A normal bone scan generally excludes a diagnosis of stress/insufficiency fracture, and the patient may return to normal activity. However, there are exceptions. In elderly or osteoporotic patients, abnormalities may not show up in bone scans for several days post-injury. Patients using corticosteroids may also have less sensitive bone scan results.

Computed Tomography

Because bone scan is often nonspecific, the length of time necessary for the examination, and the frequency with which supplemental imaging is required, there is consensus in the literature that cross- sectional imaging should supersede bone scan as the imaging of choice for stress fracture when the radiograph is negative. There are specific sites for which CT is particularly well-suited, such as sacrum and tarsal navicular bones. If the patient was symptomatic for several weeks before imaging was performed, the CT study may show periosteal reaction, sclerosis, or the fracture lines themselves.

However, axial CT alone may have false negatives due to the constraint of the axial plane (in one study, half of stress fractures were inadequately demonstrated on CT). Therefore, if CT is used to confirm stress fracture in a long bone, multiplanar reformatting is necessary. Fine detail may be achieved using thinner sections and high-end multislice scanners (64 slices or more).

Magnetic Resonance Imaging

MRI is extremely sensitive and appears to demonstrate stress abnormalities as early as bone scan does and with as much sensitivity. Indeed, the recent literature favors MRI as the procedure of choice for making an early diagnosis of either variety of stress fracture. In this regard, it outperforms radiography, radionuclide scanning, and CT. Short tau inversion recovery (STIR) sequences are emerging as the favored initial sequence for MRI screening. With a small field of view (FOV), STIR and/or T1 imaging will usually demonstrate a fracture line, surrounded by edema. In the absence of an actual stress fracture, stress reaction or muscle/tendon injuries are identified in the STIR sequence. Thus, a careful MRI may be as sensitive as a bone scan, but also considerably more specific. Intravenous contrast enhancement need not be performed in most cases. The panel recommends the study be performed without and with contrast when there is a soft tissue mass adjacent to the area of abnormal bone or for ambiguous findings. One study suggests that MRI examination of an osseous stress injury may contain prognostic as well as diagnostic information, with demonstration of an actual fracture line or cortical signal portending that a longer healing time will be required.

The critical time for stress fracture to show up on MRI post-injury has not been established, although it seems that the edema pattern would be present within hours. Furthermore, the *linearity* in the distribution of abnormal signal is highly suggestive of stress fracture and serves to differentiate these injuries from bone tumors, which tend to have a *globular* pattern.

The choice of cross sectional imaging modality has not always been clear cut. Earlier studies demonstrated that the MRI pattern was nonspecific and even confusing when only edema and not the fracture line is shown. This problem seems particularly severe in differentiating sacral or pelvic insufficiency fractures from metastases. These fractures are being recognized with greater frequency as knowledge of their occurrence has become more widely known. Compounding the problem is the fact that many patients suffering from these insufficiency fractures have a history of previous malignancy, including treatment with radiation (which increases the risk of insufficiency fracture). Overreliance on nonspecific low-signal T1 and high-signal T2 MRI patterns can lead to misdiagnosis of stress fractures as more aggressive lesions. The use of in-phase and out-of-phase MRI sequences is most reliable in differentiating benign stress fractures from pathologic fractures. STIR sequences can be helpful in that they are more likely to demonstrate not only the edema pattern but also the fracture lines themselves. In some of these cases, CT may be necessary to add specificity to the diagnosis.

MRI may, however, also demonstrate other reasons for occult pelvic pain, such as soft-tissue abnormality or the supra-acetabular stress fractures described in some osteoporotic patients. Conversely, it is recommended that MRI for hip fractures also include the sacrum since stress fractures of the sacrum appear to be associated with stress-related hip pain in young adult patients.

MRI of long bones often shows the fracture line itself. In this case, MRI is not only sensitive but also specific (fracture line seen in 11 of 14 stress

fractures, 7 of 9 hip fractures, and 13 of 13 true positive hip fractures). The sites where this phenomenon has been evaluated most completely are the hip and acetabulum, which may yield false negatives early on both radiographs and bone scan of the osteoporotic patient. Some experts recommend that a single T1 MRI sequence in the plane of interest be performed and initially evaluated when stress fracture is suspected. If a fracture line is clearly seen, the examination may be terminated. If the question persists after the single sequence, other sequences may be used for more complete examination (e.g., STIR or FSE T2 sequences for even more sensitive evaluation of marrow edema, or nearby soft-tissue injury). Intravenous contrast should not be required. In a younger patient population (e.g., military recruits), STIR imaging has a higher accuracy than T1 imaging and may be chosen as the initial MRI sequence.

Another circumstance that deserves specific attention is the longitudinal stress fracture, particularly in the tibia. Up to 25% may appear normal on radiographs, but CT or MRI findings are characteristic. MRI is very sensitive to the bone marrow edema accompanying these longitudinal fractures, and may give a misleadingly aggressive appearance.

Summary

- Patients with suspected fatigue or insufficiency fractures should be imaged initially with radiographs. In many instances the abnormality will be apparent.
- MRI is the clear-cut choice for imaging, particularly in the elite athlete, in the elderly, and in those patients who are dependent on using the injured limb in their work. As a rule, MRI need not be performed using contrast enhancement except in special circumstances such as adjacent soft-tissue mass or ambiguous findings.
- CT may be needed to confirm the diagnosis, particularly in cases of insufficiency fractures of the sacrum and pelvis.

Abbreviations

- CT, computed tomography
- MRI, magnetic resonance imaging
- NS, not specified
- SPECT, single-photon emission computed tomography
- Tc-99m, technetium-99 metastable

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☐	<0.1 mSv	<0.03 mSv
☐☐	0.1-1 mSv	0.03-0.3 mSv
☐☐☐	1-10 mSv	0.3-3 mSv
☐☐☐☐	10-30 mSv	3-10 mSv
☐☐☐☐☐	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Stress (fatigue/insufficiency) fractures including sacrum, excluding other vertebrae

Guideline Category

Diagnosis

Clinical Specialty

Emergency Medicine

Family Practice

Geriatrics

Nuclear Medicine

Orthopedic Surgery

Radiology

Sports Medicine

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for stress (fatigue/insufficiency) fractures including sacrum, excluding other vertebrae

Target Population

Patients with suspected stress (fatigue/insufficiency) fractures including sacrum, excluding other vertebrae

Interventions and Practices Considered

1. X-ray
    - Area of interest
    - Sacrum
    - Pelvis
2. Magnetic resonance imaging (MRI)
    - Area of interest without contrast
    - Area of interest without and with contrast
    - Sacrum without contrast
    - Sacrum without and with contrast

- Pelvis without contrast
- Pelvis without and with contrast

3. Computed tomography (CT)
    - Area of interest without contrast
    - Area of interest with contrast
    - Area of interest without and with contrast
    - Sacrum without contrast
    - Sacrum with contrast
    - Sacrum without and with contrast
    - Pelvis without contrast
    - Pelvis with contrast
    - Pelvis without and with contrast
4. Technetium (Tc)-99m bone scan whole body with single photon emission computed tomography (SPECT) area of interest

Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is

circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures to evaluate possible stress (fatigue/insufficiency) fractures

Potential Harms

- In elderly or osteoporotic patients, abnormalities may not show up in bone scans for several days post-injury. Patients using corticosteroids may also have less sensitive results.
- Axial computed tomography (CT) alone may also have false negatives due to the constraint of the axial plane (in one study, half of stress fractures were inadequately demonstrated on CT). Therefore, if CT is used to confirm stress fracture in a long bone, multiplanar reformatting is necessary. Fine detail may be achieved using thinner sections and high-end multislice scanners (64 slices or more).

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Daffner RH, Weissman BN, Appel M, Bancroft L, Bennett DL, Blebea JS, Bruno MA, Fries IB, Hayes CW, Kransdorf MJ, Luchs JS, Morrison WB, Palestro CJ, Roberts CC, Stoller DW, Taljanovic MS, Tuite MJ, Ward RJ, Wise JN, Zoga AC, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness CriteriaÂ® stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae. [online publication]. Reston (VA): American College of Radiology (ACR); 2011. 9 p. [40 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1995 (revised 2011)

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Musculoskeletal Imaging

Composition of Group That Authored the Guideline

Panel Members: Richard H. Daffner, MD; Barbara N. Weissman, MD; Marc Appel, MD; Laura Bancroft, MD; D. Lee Bennett, MD, MA; Judy S. Blebea, MD; Michael A. Bruno, MD; Ian Blair Fries, MD; Curtis W. Hayes, MD; Mark J. Kransdorf, MD; Jonathan S. Luchs, MD; William B. Morrison, MD; Christopher J. Palestro, MD; Catherine C. Roberts, MD; David W. Stoller, MD; Mihra S. Taljanovic, MD; Michael J. Tuite, MD; Robert J. Ward, MD; James N. Wise, MD; Adam C. Zoga

Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Daffner RH, Weissman BN, Bennett DL, Blebea JS, Jacobson JA, Morrison WB, Resnik CS, Roberts CC, Rubin DA, Schweitzer ME, Seeger LL, Taljanovic M, Wise JN, Payne WK, Expert Panel on Musculoskeletal Imaging. ACR Appropriateness Criteria® stress/insufficiency fracture, including sacrum, excluding other vertebrae. [online publication]. Reston (VA): American College of Radiology (ACR); 2008. 8 p. [48 references]

The appropriateness criteria are reviewed biennially and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site .

- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria® stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae. Evidence table. Reston (VA): American College of Radiology; 2011. 9 p. Electronic copies: Available from the ACR Web site.

Patient Resources

None available

NGC Status

This summary was completed by ECRI on May 6, 2001. The information was verified by the guideline developer as of June 29, 2001. This summary was updated by ECRI on March 28, 2006. This summary was updated by ECRI Institute on June 29, 2009. This summary was updated by ECRI Institute on July 7, 2011.

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